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Yamashita et al.

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(45) **Date of Patent: Mar. 20, 2001**

(54) **LEVER-TYPE CONNECTOR**

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(51) **Int. Cl.**[7] **H01R 13/62**
(52) **U.S. Cl.** **439/157**
(58) **Field of Search** 439/157, 155, 439/310, 372, 152, 153, 154, 159, 160

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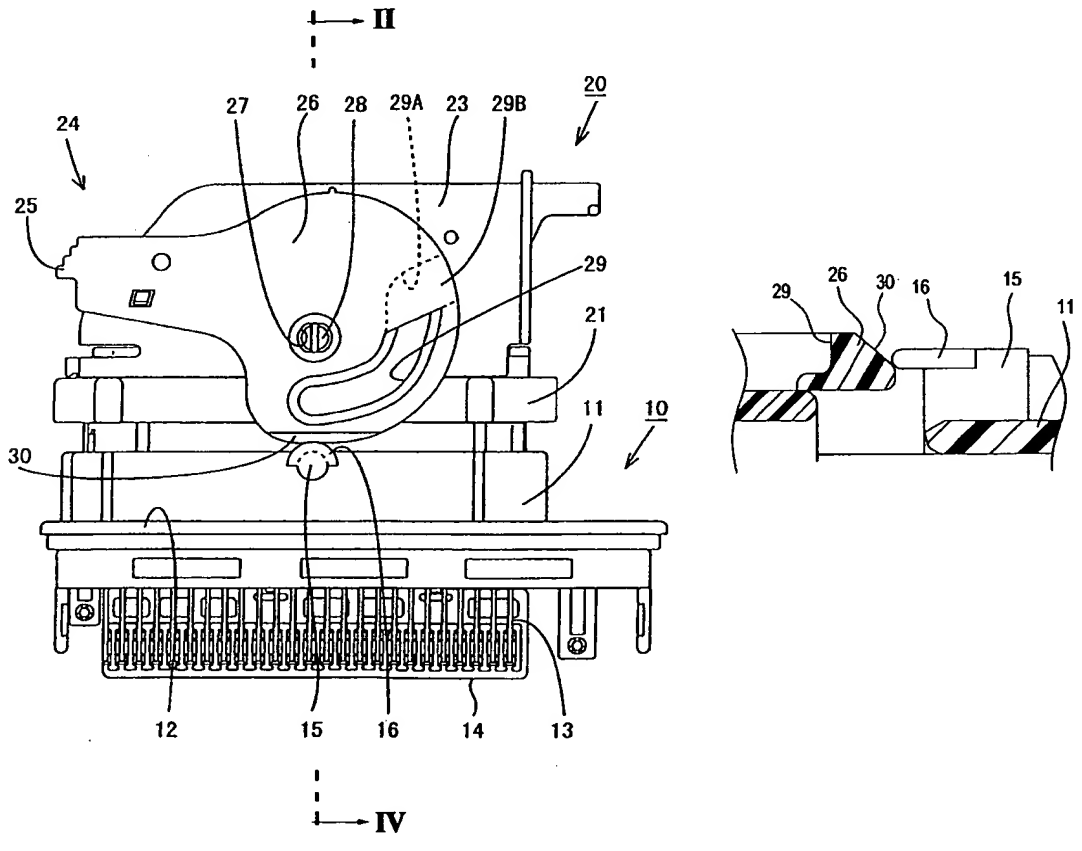
Assistant Examiner—Tho D. Ta
(74) *Attorney, Agent, or Firm*—Oliff & Berridge, PLC

(57) **ABSTRACT**

A lever-type electrical connector has connector housings and a lever rotatably mounted on a first connector housing. The lever has a cam track with an entrance end. A cam pin on the second connector housing enters the entrance end of the cam track when the connector housings are brought together with the lever in a waiting position, and by the interaction of the cam pin and the cam track, when thereafter the lever is rotated to a locking position, the connector housings are drawn together into a fully fitted conformation. At least one of the lever and the cam pin has an edge surface inclined with respect to the fitting direction whereby, when the lever is incorrectly located so that the pin is not received in the entrance end of said cam track, the lever and the pin interact at the inclined edge surface to prevent the lever from over-riding the pin.

5 Claims, 8 Drawing Sheets



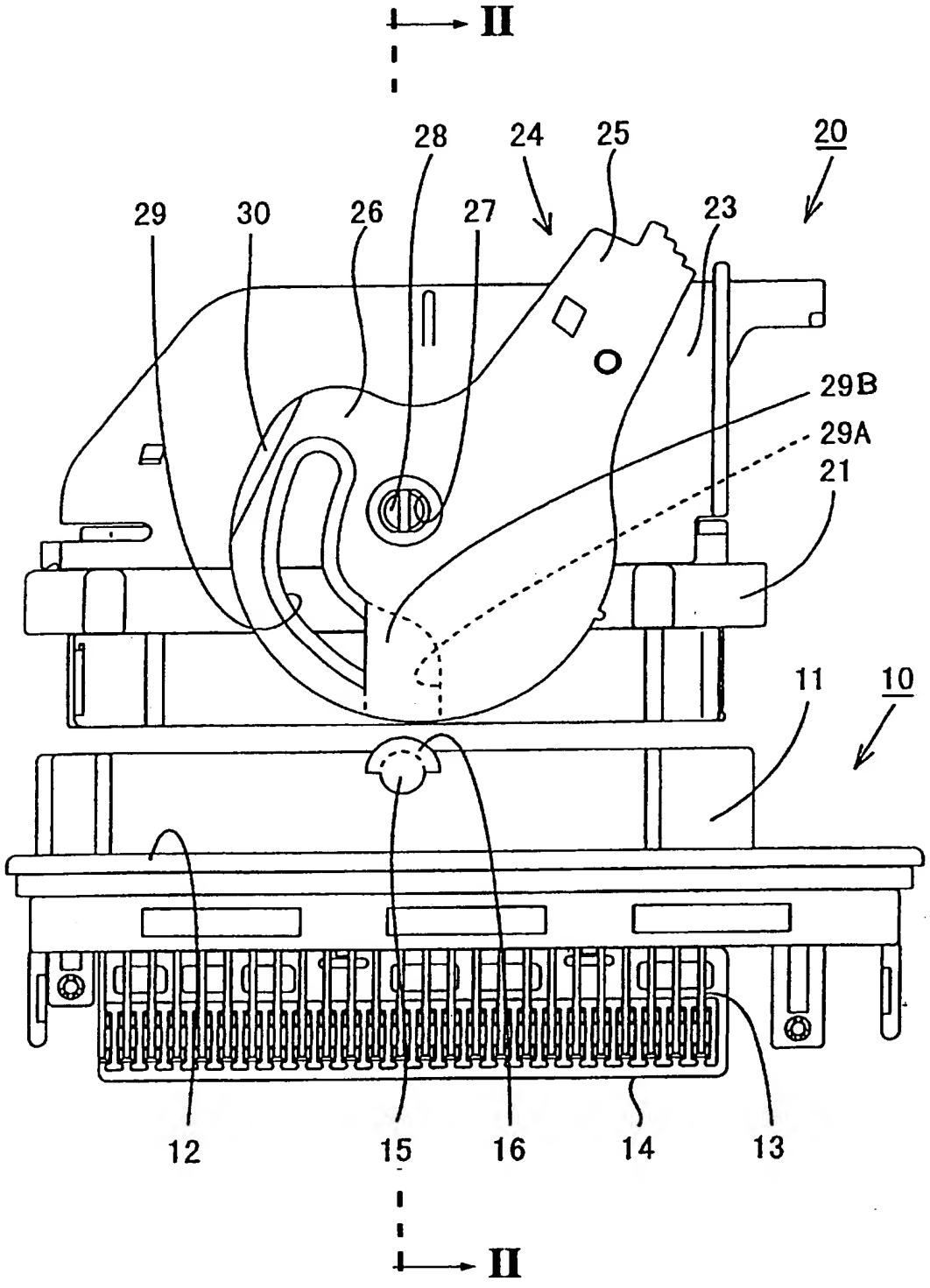


Fig. 1

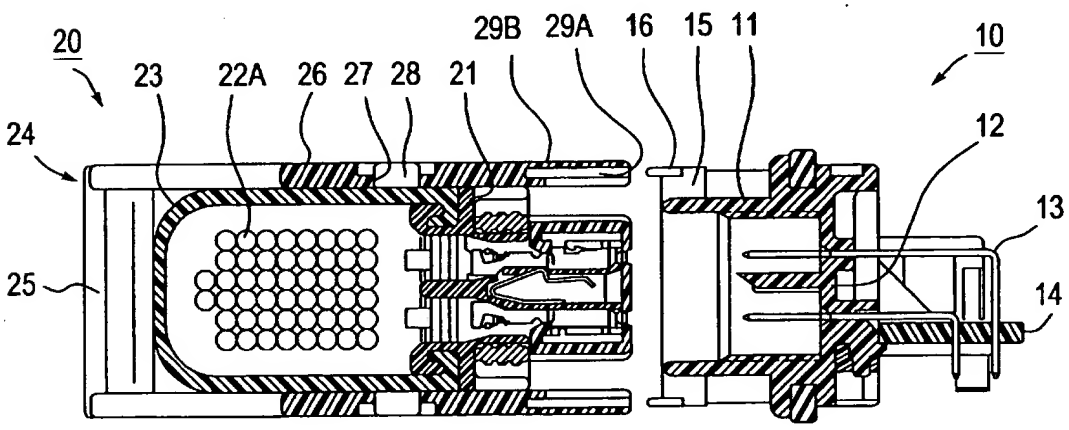


Fig. 2

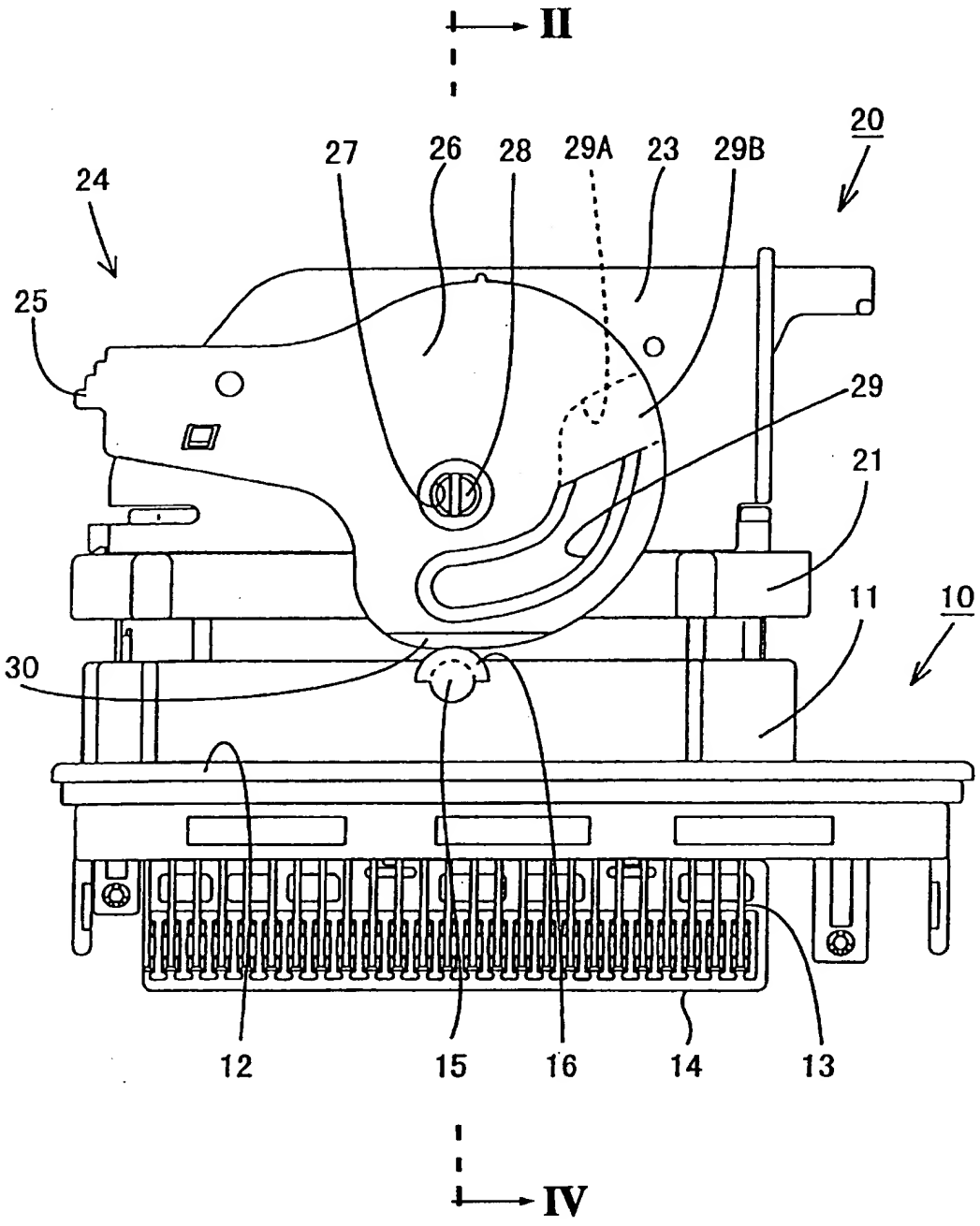


Fig. 3

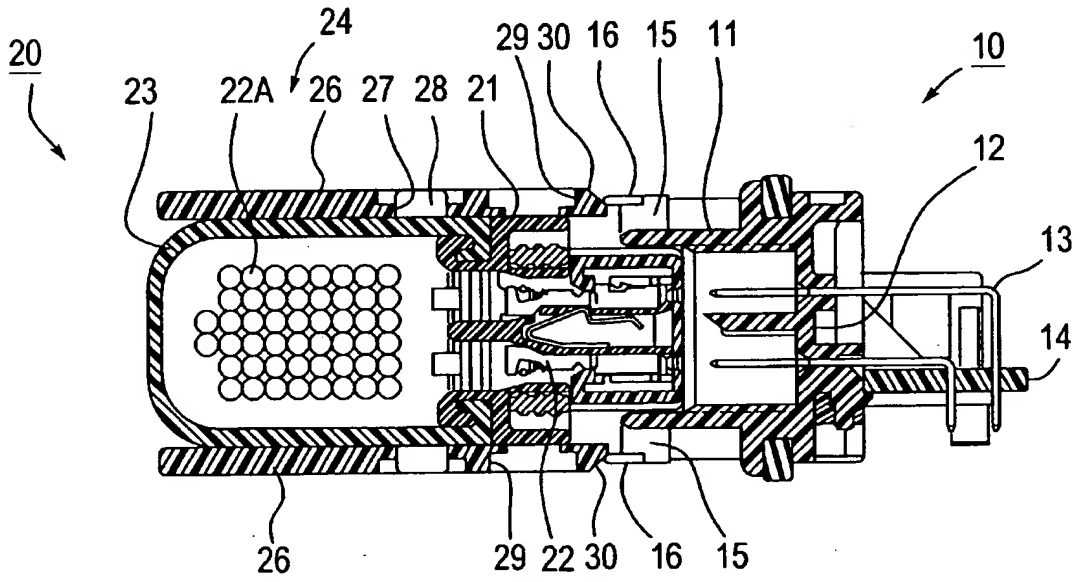


Fig. 4

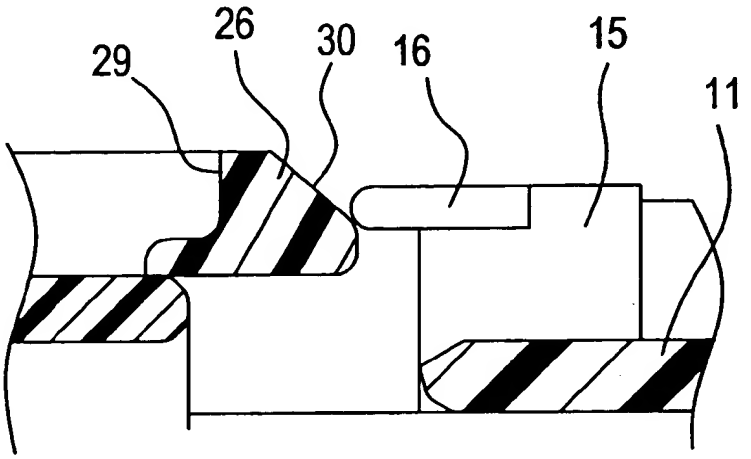


Fig. 5

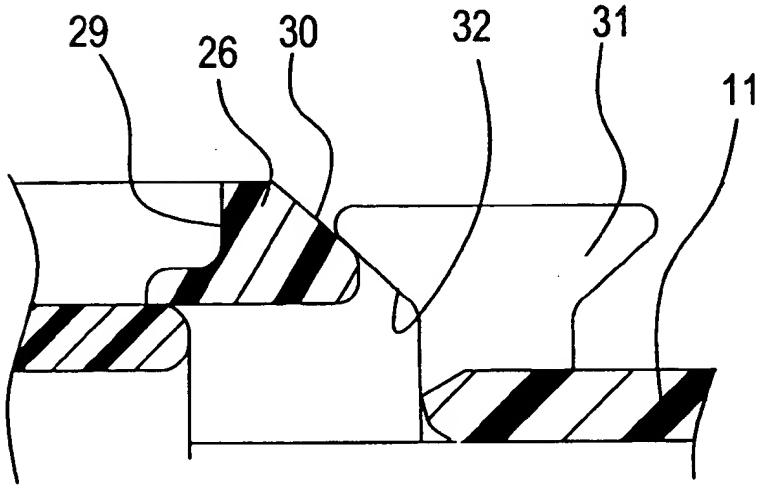


Fig. 6

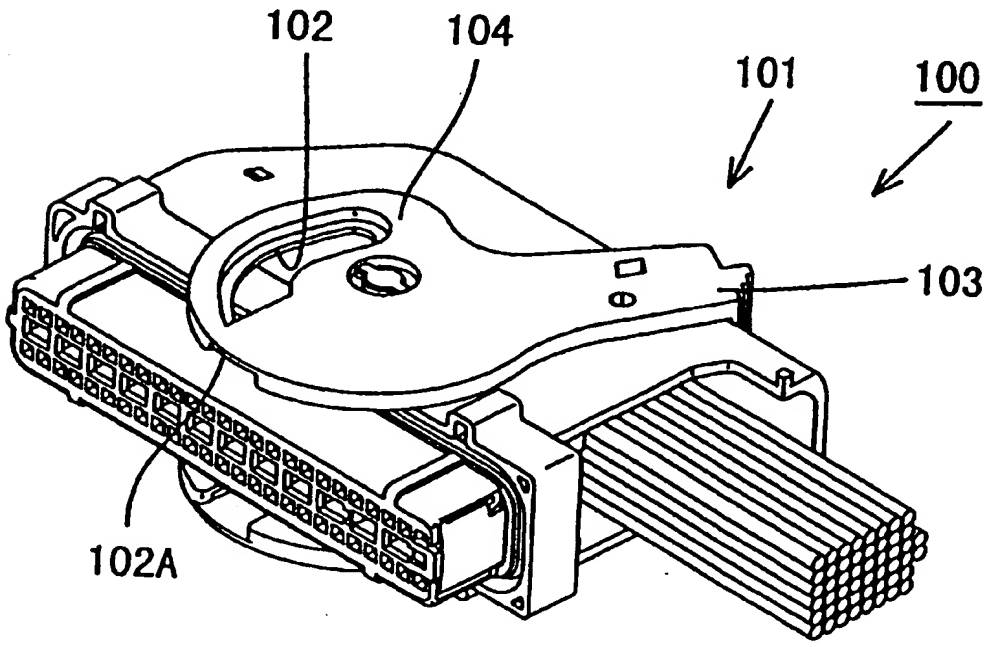


Fig. 7

PRIOR ART

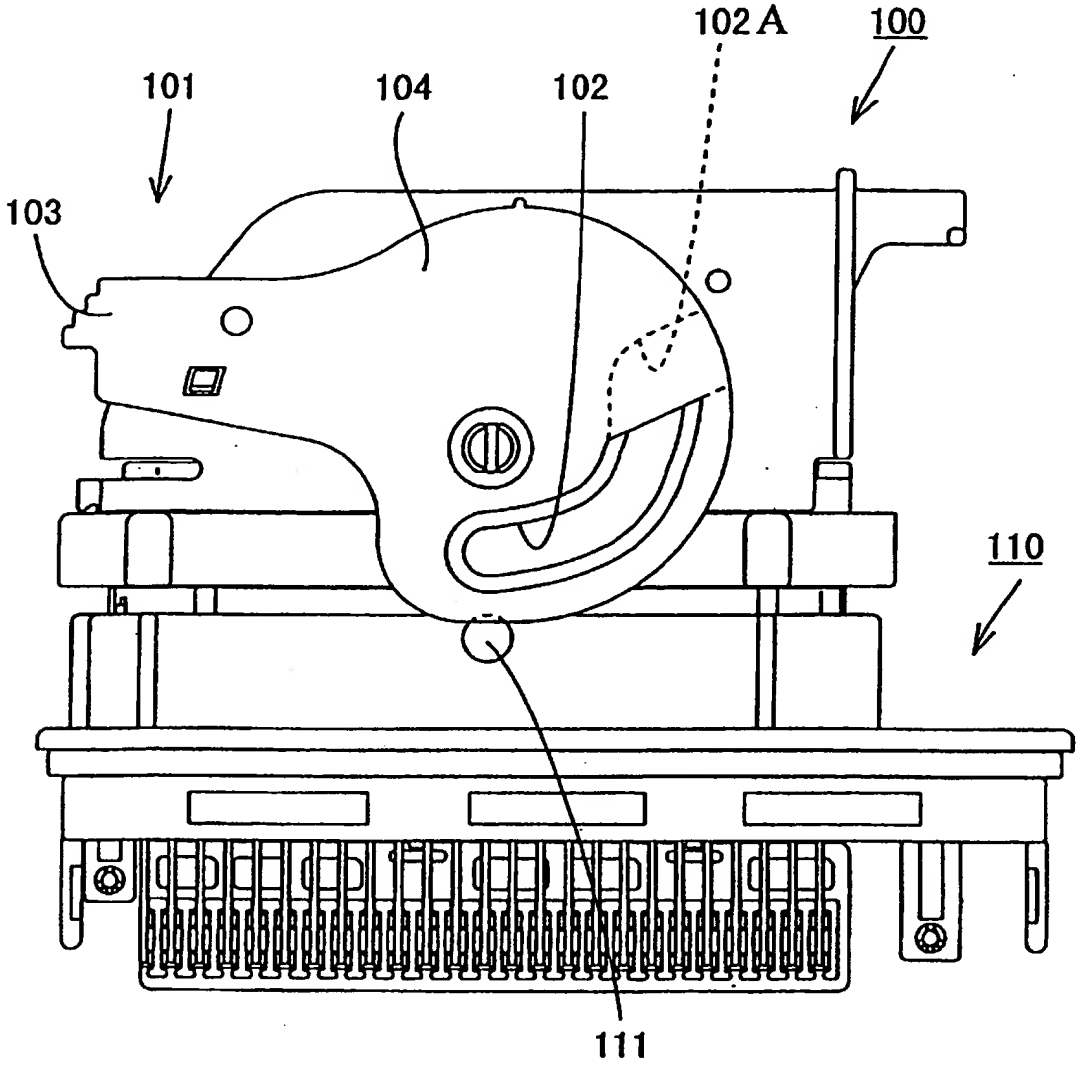


Fig. 8

PRIOR ART

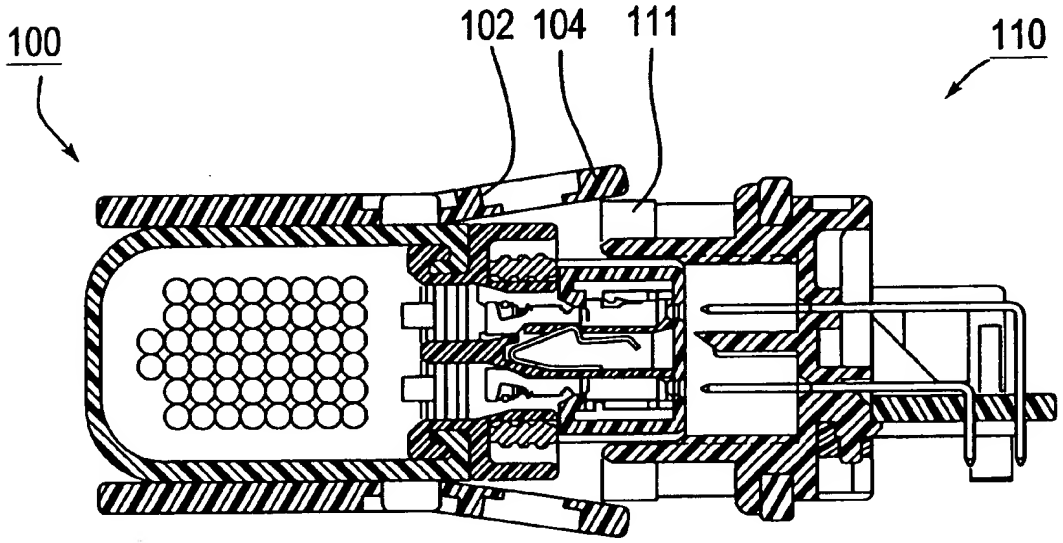


Fig. 9
PRIOR ART

LEVER-TYPE CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a lever-type connector, in particular an electrical connector having housings containing electrical elements which are connected when the housings are fitted together.

2. Description of the Related Art

FIGS. **7** through **9** show a conventional lever-type connector. A lever **101** is rotatably supported by a first connector housing **100** which fits into a mating second connector housing **110** in order to make an electrical connection between arrays of terminals in the housings **100,110**. Cam pins **111** on the second connector housing **110** engage cam groove **102** of the lever **101**. The lever **101** has a pair of plate-shaped arm portions **104**, one on each side of the housing, extending to an operation portion **103**. The operation portion **103** preferably connects the plate-shaped arm portions **104** together in a substantially rigid manner. This allows the plate-shaped arm portions **104** to more easily be rotated in unison. The cam grooves **102** are formed in the respective arm portions **104**.

When fitting the two connector housings **100, 110** to each other, the lever **101** is set in a predetermined waiting posture with the entrance **102A** of the cam groove **102** open toward the second connector housing **110**. In this state, the connector housings **100, 110** are approached to each other parallel to the surfaces of the arm portions **104** and partially fitted into each other so that the cam pin **111** penetrates into the entrance **102A** of the cam groove **102** on each side. The lever **101** is rotated, drawing the connector housings **100, 110** tightly together by a cam action due to the engagement between the cam grooves **102** and the cam pins **111**. This kind of lever-type connector is disclosed in JP-A-6-275337.

Let it be supposed that in fitting the connector housings **100, 110** together, the lever **101** is not set at the waiting posture, so that the entrance **102A** of the cam groove **102** is not at its position to receive the pin **111**. In this case, when the connector housings **100, 110** are approached to each other, the periphery of the cam pin **111** collides with the peripheral edge of the arm portion **104**. The operator thus discovers that the lever **101** is located at an inappropriate position. However, if the operator does not notice that the periphery of the cam pin **111** has collided with the peripheral edge of the arm portion **104** and proceeds with the fitting operation forcibly, the arm portion **104** may deform outwardly, thus riding over the cam pin **111**. As a result, the arm portions **104** disengage from the peripheral surfaces of the cam pins **111**, and the connector housings **100, 110** may be fitted in each other incompletely, with the cam pins **111** and the cam grooves **102** not in engagement with each other, as shown in FIGS. **8** and **9**.

U.S. Pat. No. 5,476,390 shows a connector similar to that of FIGS. **7** to **9**, in which the cam pins have a chamfer at their extremity, which may tend to encourage over-riding of the lever on the pin.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a lever-type electrical connector in which it is possible to reliably prevent a pair of connector housings from being fitted to each other when the posture of a lever with its movement range is incorrect.

According to the invention there is provided a lever-type electrical connector including a pair of connector housings

adapted to be fitted together to effect electrical connection, and a lever rotatably mounted on a first one of the connector housings for rotation between a waiting position and a locking position, the lever having surfaces defining a cam track. A cam follower is provided on the second of the connector housings in the form of an upstanding member located so as to enter the entrance end of the cam track when the connector housings are brought together in a predetermined fitting direction with the lever in the waiting position. The interaction of the cam follower and the cam track, when thereafter the lever is rotated to the locking position, causes the connector housings to be drawn together into the fitted position. At least one of the lever and the cam follower has an edge surface which is inclined relative to the fitting direction such that, when the lever is at a rotational position such that the cam follower is not correctly received in the entrance end of the cam track, the lever and the cam follower interact at the inclined edge surface to prevent the lever over-riding on the cam follower.

Preferably, the lever has an arm portion in which the cam track is defined, and the cam follower is a pin projecting outwardly from a face of the second connector housing. The arm portion and the pin interact at the inclined edge surface so as to urge the arm portion towards the face of the second connector housing. The pin may have a projecting flange which interacts with the inclined edge surface to urge the arm portion towards the second connector housing.

Alternatively, both the lever and the cam follower have edge surfaces inclined relative to the fitting direction. The two edge surfaces interact to prevent the lever from over-riding the cam follower.

In the connector of the invention, when the two connector housings are brought together, with the lever set in an inappropriate position within its rotation range, the inclined peripheral edge, which is for example on an arm portion of the lever, collides with the cam pin. At this time, the inclined surface subjects the arm portion to a guiding force towards the connector housing, not away from it. Therefore, the arm portion is prevented from being lifted from the cam pin. Thus it is possible to prevent the fitting of the connector housings to each other when the lever is located at an inappropriate position.

It is preferable to make the inclination of the inclined surface gentle to allow the guiding operation of the inclined surface to be performed smoothly. If the tapered surface having a gentle inclination is formed on the cam pin, it may be necessary to increase the diameter of the cam pin, but there are dimensional restrictions in its design. Preferably therefore the inclined surface is formed on the arm portion and can be much larger than on the cam pin. Thus, the inclination of the inclined surface can be set as desired. Preferably this inclination of the inclined surface is at not more than 60°, more preferably not more than 45° relative to the insertion direction.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described by way of nonlimitative example with reference to the accompanying drawings, in which:

FIG. **1** is a plan view of a connector which is a first embodiment of the invention, showing a state in which two connector housings of the connector are separated from each other;

FIG. **2** is a sectional view of the connector of FIG. **1** on line II—II of FIG. **1** showing a state in which the two connector housings are separated from each other;

FIG. 3 is a plan view of the connector of FIG. 1 showing a state in which the two connector housings are fitted to each other, with the lever located at an incorrect position;

FIG. 4 is a sectional view on line IV—IV of FIG. 3;

FIG. 5 is a partial enlarged diagrammatic side view showing an arm portion of the lever and a cam pin interfering with each other when the lever is located at the incorrect position;

FIG. 6 is a partial diagrammatic view, corresponding to FIG. 5, of the lever and cam pin in a second embodiment of the invention;

FIG. 7 is a perspective view showing a conventional lever-type connector;

FIG. 8 is a plan view of the connector of FIG. 7; and

FIG. 9 is a sectional view of the connector of FIG. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A lever-type connector which is a first embodiment of the present invention will be described with reference to FIGS. 1 through 5. The connector is composed of a male connector housing **10** and a female connector housing **20** which can be detachably fitted to each other. The male connector housing **10** is for example installed on a circuit substrate (not shown). The male connector housing **10** has a generally rectangular hood portion **11** open in a forward direction and a rear wall portion **12** sealing the rear end of the hood portion **11**. L-shaped long and narrow male metal terminal fittings **13** are fixed in and penetrate through the rear wall portion **12**. One end of each male metal terminal fitting **13** projects into the hood portion **11**, whereas the other end thereof penetrates downward through an alignment plate **14** installed on the housing **10**. Cam pins **15** are formed on the upper surface and lower surface of the housing **10**. The cam pins **15** are preferably coaxial with each other. As shown in FIG. **5**, each cam pin **15** is mainly cylindrical and has a uniform outer diameter in its axial direction. A semi-circular arc-shaped lip or flange **16** of a larger diameter than or main body portion of the cam pin **15** projects outward from the periphery of the top (outer) end of each cam pin **15**, and extends around about the half of the periphery of the cam pin **15** so as to be directed towards the female connector housing **20**.

The female connector housing **20** has a body **21** accommodating female metal terminal fittings **22**, a cover **23** disposed rearwardly from the rear surface of the body **21** and guiding electric wires **22A** in a lateral direction, and a lever **24** installed on the cover **23**. The lever **24** has a pair of upper and lower planar sheet-like arm portions **26** joined integrally by an operating portion (handle) **25**. Force is applied to the operating portion **25** to move the lever **24**. The lever **24** is installed on the cover **23** by fitting a spigot or shaft **28** provided on each side of the cover **23** into a bearing hole **27** of the respective arm portion **26**. The lever **24** rotates on the shafts **28** between the waiting position shown in FIG. **1** and the fitted position shown in FIG. **3**. In the rotation of the lever **24**, the arm portions **26** rotate parallel to and close to the outer surface of the body **21** and that of the cover **23**. The arm portions **26** are parallel to the mutual fitting direction of the male and female connector housings **10**, **20**.

A curved cam groove **29** constituting a cam track is formed on each arm portion **26** and extends partially around the shaft **28**. The cam groove **29** is open as a slot on both the inner and outer surfaces of the arm portions **26** except at an entrance **29A** to the groove which is open at the peripheral edge of the arm portion **26**. A reinforcing plate **29B** closes over the entrance **29A** of the groove **29** at the outer side of the arm portion **26**. The peripheral edge of the arm portion **26** adjacent the groove **29** is preferably curved to extend almost parallel to the outer edge of the groove **29**.

In fitting the housings **10** and **20** to each other, first the lever **24** is rotated to the waiting position (FIG. **1**), so that the entrance **29A** of the cam groove **29** confronts the cam pin **15**. In this state, the housings **10**, **20** are brought together in a direction parallel to the plane of each arm portion **26** and partially fitted to each other so that the cam pins **15** penetrate into the entrances **29A** of the two cam grooves **29**. Then the lever **24** is rotated, so that the housings **10**, **20** are forcibly bought together by the cam action caused by the engagement between the cam grooves **29** and the cam pins **15**. When the lever **24** reaches the fitted position, the housings **10**, **20** are completely fitted together.

Let it be supposed that the lever **24** is not set at the waiting position, i.e. that the entrance **29A** of the cam groove **29** does not confront the cam pin **15** but is displaced laterally from it. In this case, when the housings **10**, **20** are brought together, the peripheral surface of the cam pin **15** and the peripheral edge of the arm portion **26** contact each other. It is to be noted that in the case of the conventional lever-type connector, if the connector housings are forcibly brought together, the arm portion deforms and rides over the front-end (upper end) surface of the cam pin. As a result, the connector housings are fitted in each other incompletely.

The lever-type connector of this embodiment of the invention has a structure that prevents the deformation of the arm portion **26**. A chamfer or tapered surface **30** is formed on the peripheral edge of each arm portion **26** by forming the outer surface of the arm portion **26** at an inclination with respect to the fitting direction of the housings **10**, **20** along a region adjacent the inner end of the groove **29** remote from the groove entrance **29A**, i.e. at the location which confronts the pin **15** if the lever **24** is in the fitting position of FIG. **3**. This region of the periphery therefore interferes with the cam pin **15** when the lever **24** is located in the fitting position mistakenly, not in the waiting position. The tapered surface **30** contacts the inner-side edge of the lip **16** of the cam pin **15** (side towards the hood **11**) as the housings **10**, **20** approach each other. Thereafter, force applied to move the housings **10**, **20** towards each other acts to displace the peripheral edge of the arm portion **26** inward, i.e. towards the cover **23**.

In this way, it is possible to prevent the arm portion **26** from deforming elastically so that it rides over the cam pin **15**. The operator is prevented from fitting the housings **10**, **20** together in an incorrect or incomplete manner, by the stop action of the engagement of the arm portion **26** and the pin **15**. This mis-fitting is easily noticed, so that correct operation of fitting the housings **10**, **20** to each other will occur more reliably.

It is preferable to make the inclination of the tapered surface **30** gentle to allow its guiding operation to be performed smoothly. If a tapered surface having a gentle inclination is formed on the cam pin **15**, it is necessary to increase the diameter of the cam pin **15**, but there are dimensional restrictions in its design. However, in the embodiment, the tapered surface **30** is formed on the arm portion **26**, which is much larger than the cam pin **15**. Thus, the inclination of the tapered surface **30** can be set as desired.

A lever-type connector which is a second embodiment of the invention is shown partially in FIG. **6**. Only the points on which this embodiment differs from that of FIGS. **1** to **5** are described. In the first embodiment, the tapered surface **30** is

formed on only the arm portion **26**, whereas in the second embodiment, a tapered surface is formed both on the arm portion and on the cam pin. The cam pin **31** of the second embodiment is tapered so that its diameter increases toward its outer end (upper end in FIG. **6**) to form a tapered surface **32** on the underside of the head of the cam pin **31**. The lip **16** of FIGS. **1** to **5** is not present. The engagement of the tapered surface with the pin **31** is indicated in FIG. **6**.

The present invention is not limited to the above-described embodiments. For example, at least the following variations are included in the technical scope of the present invention.

(1) In the above description, the tapered surface is formed only on the peripheral edge of the arm portion, or on both the arm portion and the cam pin. However, according to the present invention, the tapered surface may be formed on only the cam pin.

(2) In the above description, the lever is formed on the female connector housing. But the lever may be formed on the male connector housing.

(3) In the above description, the lever-type connector is installed on a circuit substrate. Alternatively, the lever-type connector is also applicable to a wire-to-wire type connector.

(4) In the above-described FIGS. **1** through **5**, the lip **16** is formed on a semicircular arc region of the cam pin, confronting the male connector housing. However, this lip **16** may be formed on the entire circumference of the cam pin.

(5) In the above description, the tapered surface **30** is formed at only the region that interferes with the cam pin when the lever is located at the fitting position. Within the present invention, the tapered surface may be formed in a wide range such that it interferes with the cam pin when the lever is located at any position between the fitted position and the waiting position.

Although the invention has been described above in relation to particular embodiments, many variations are possible within the spirit and scope of the invention herein described, as will be clear to those skilled in the art.

What is claimed is:

1. A lever-type electrical connector comprising

a pair of connector housings that fit together to effect an electrical connection,

a lever rotatably mounted on a first one of said connector housings for rotation between a waiting position and a fitted position, said lever having a surface defining a cam track, said cam track having an entrance end,

a cam follower provided on a second one of said connector housings, the cam follower being located so as to enter said entrance end of said cam track when said connector housings are brought together in a predetermined fitting direction with said lever in said waiting position, the interaction of said cam follower and said cam track, when thereafter said lever is rotated to said fitted position, causing said connector housings to be drawn together into a fitted state,

wherein at least one of said lever and said cam follower has an edge surface which is inclined relative to said fitting direction such that, when said connector housings are brought together, and when said lever is at a rotational position such that said cam follower is not received in said entrance end of said cam track, said lever and said cam follower interact at said edge surface to prevent said lever from over-riding said cam follower.

2. A lever-type electrical connector according to claim **1**, wherein each of said lever and said cam follower have said edge surface inclined relative to said fitting direction, said edge surfaces interacting with each other to prevent said lever from over-riding said cam follower.

3. A lever-type electrical connector according to claim **1**, wherein said lever has an arm portion in which said cam track is defined and said cam follower is a pin projecting outwardly from a face of said second connector housing, and said arm portion and said pin interact at said edge surface so as to urge said arm portion towards said face of said second connector housing.

4. A lever-type electrical connector according to claim **3**, wherein said edge surface is provided on said arm portion.

5. A lever-type electrical connector according to claim **4**, wherein said pin has a projecting flange which interacts with said edge surface on said arm portion to urge said arm portion towards said face of said second connector housing.

* * * * *